WAC/053(19.02.99)

nsma
national spectrum managers association

February 9, 1999

Subject: Draft Recommendation WG3.98.049

Dear Fellow NSMA Members:

Attached for your review and comment is a WG3 recommendation concerning frequency coordination of Earth Stations on Board Vessels. The comments are due March 15, 1999.

In parallel with this, some substantive comments already received are being sent to WG3 so that they may begin to address these issues.

Comments are to be sent to Lionel Burns - NSMA Secretary, copying Dave Popkin - Chairman WG3 at the following addresses:

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Lionel Burns
NSMA Secretary

Submitted by the NSMA Board of Directors for membership review and comment.
Comments are due March 15, 1999.

DRAFT NSMA RECOMMENDATION
WG3.98.049

SUBJECT: Earth Stations on Board Vessels (ESV): Frequency Coordination Procedures

1. INTRODUCTION and SCOPE

C-band earth stations have begun to be used aboard ships while in motion. Since these earth stations aboard vessels (ESVs, alternately referred to as shipboard earth stations) transmit on frequencies used by fixed microwave systems, it is important to control the interference into these fixed systems. This document, which consists of the following sections, establishes recommendations for management of interference from ESV transmitters into terrestrial fixed receivers.

1. Introduction, Scope and Assumptions
2. Method for Interference Analysis
3. ESV Interference Objectives
4. Operational Controls
5. Prior Coordination Notice (PCN) Data Requirements
6. ESV Accommodation of Future Fixed Installations

In order to accommodate the mobility aspect of ESV transmissions, several assumptions are made to facilitate more controlled modeling of the interference environment and more accurate prediction of interference effects. Operation of the ESV outside of the ranges established by these assumptions is considered not to be in compliance with this Recommendation and requires that steps be taken to discontinue operation. These assumptions are as follows:

1. Because of the size and weight of C-Band earth stations mounted on vessels, including the necessary stabilization platform to hold the dish antenna on path, these earth stations aboard vessels are assumed to be used only on “deep draft” ships and vessels. This recommendation only applies to deep draft vessels operating in charted deep draft sea lanes. All operation within the coordination distance from shore must be prior

coordinated; that is, areas outside charted sea lanes, but within the coordination distance must also be coordinated.

2. Shore is defined as any terrestrial point of US/Canadian Territory or any fixed microwave station operating on an offshore structure.

3. ESVs will maintain a minimum speed of 5 knots (9.26 km/hour) when within the coordination distance from shore. Stops or operation at lower speeds within this perimeter, including maneuvering in the vicinity of the pier, must be coordinated separately or transmitter operation must be discontinued. Unplanned stops at locations within the coordination distance that are not coordinated for fixed operations are not accounted for in these procedures. Transmissions during such unplanned stops are considered uncoordinated operations and provisions must be taken to ensure that transmitter operation at such times does not occur.

4. ESV operation within the coordination distance from shore will require completion of coordination prior to operation. See Section 2.6 for a discussion of coordination distance.

2. METHOD for INTERFERENCE ANALYSIS

This section outlines a method for analyzing the potential interference from shipboard earth station transmitters into point-to-point microwave station receivers sharing the same frequencies. The method described herein deals with analysis of interference from the ESV source while it is in motion. The proposed frequency coordination process includes use of C-Band operational parameters that would be considered in terrestrial coordination cases as well as additional parameters resulting from the in-motion (mobile) operations of the ESV.

There are essentially two modes of operation for shipboard earth stations: fixed (while the vessel is stopped or docked at a pier), and under way. The method of analysis for fixed operation is the same as for any other individually coordinated earth station in the Fixed Satellite Service. The analysis method for shipboard earth stations while they are in motion, on the other hand, requires a different approach.

Key considerations for interference analysis and frequency coordination of shipboard earth stations while in motion:

1. Clear identification of the ship's permissible operating contour, such as the deep-draft channel leading into port, and the limits of deep-draft operation within the coordination distance from shore when outside of port;

2. The minimum coordination distance from shore and the specific coordination distance applicable to in-motion operations;

3. Determination of the single point that represents the worst-case interference exposure to that microwave receiver from a shipboard earth station;

4. A conclusion, based on the above worst-case assumption, that if the calculated interference from that "critical contour point" meets the applicable interference objective, then that point and all of the other points within the mobile operational contour represent non-interfering locations;

5. The ability to identify that single, critical contour point.

Item 1, which must be provided by the ESV operator, and Item 2, above, represent inputs to the method for analyzing the potential interference. Items 3 through 5, however, focus more on the interference analysis method itself.

2.1 The Concept of "Critical Contour Point"

Consider that for any interference exposure from a shipboard earth station to a particular microwave station, the only position-related variables in the calculation are the following:

1. Interfering path distance (as it relates to free space path loss);

2. Fixed microwave antenna gain/discrimination in the direction of interest;

3. Earth station horizon gain/discrimination in the direction of interest; and

4. Additional path loss that may exist on the particular interference path (OH Loss).

For every point within the ESV operational contour, each of these factors can be readily determined, as can the combination of all four factors. The point within the contour representing the worst-case combination (in terms of potential interference) of all four factors represents the “critical contour point” for that particular microwave station.

Potential victim microwave stations within the coordination distance can be grouped into two categories: those whose main beam (extended if necessary) will intersect the ESV operational area, and those that will not. Whether a microwave station falls into one or the other of these two categories, though, it is expected that there is a single ESV location that will produce worst case interference.

2.2 Paths with Intersections

For many microwave stations, extension of the microwave receiver antenna’s main axis toward the shipboard earth station’s operating contour produces an intersection with the contour. At that intersection, the microwave antenna has zero angular discrimination. At other azimuths, the fixed receiver antenna’s angular discrimination increases, therefore less interference is expected. Beyond the point of intersection (deeper into the contour area), there is almost always additional path loss. Therefore, one can conclude that the “critical contour point” generally exists on the edge of the operating contour closest to the microwave station, rather than inside the contour or at its farther edge.

The point defined by this intersection often represents the worst-case interference exposure for that particular microwave receiver, primarily because the microwave antenna has zero angular discrimination in that direction. Because of the overall magnitude of its variability, microwave antenna discrimination is generally the most significant of the four variables in terms of identification of a critical contour point and in performing the related interference analysis.

The worst case interference does not always occur on the extended receive azimuth, however, because the microwave antenna discrimination is only one of the four key variables in the interference calculation. There may be another point in the operating contour for which the combination of all four variables represents a higher interference exposure. One might posit that the "critical contour point" exists at a point on the edge of the contour physically closest to the microwave station, but which is not on the receive antenna main beam.

However, the variation of path loss with even relatively significant changes in distance is usually far outweighed by the variation in microwave antenna discrimination due to changes in azimuth.

Consider, too, that since the earth station main beam is elevated (pointed skyward), there is generally only about a 10 dB variation in earth station horizon gain at different azimuths. Even so, there may be a point on the edge of the contour displaced from the intersection at which the difference in earth station horizon gain (toward the microwave station) outweighs the difference in microwave antenna discrimination. In some cases, there may be significant terrain blockage of the interference path, but less or no blockage on a slightly displaced path. In these cases, the difference in blockage could outweigh the combination of respective antenna discrimination values and the applicable free space loss on the interference path (which may be longer or shorter than the path associated with the intersection).

2.3 Paths with No Intersections

Many microwave paths will have no intersection, because the extension of the antenna's main axis does not intersect the shipboard earth station's operating contour. In these cases, the "critical contour point" is still determined by the worst-case combination of the four variables. The point often will exist at the point on the contour representing the minimum angular discrimination value for the microwave antenna-usually one of the extreme points of the contour, either the pier itself or one of the points farthest out to sea.

2.4 The Process of Identifying “Critical Contour Points”

Initiating frequency coordinators may use a variety of approaches to identify the critical contour point for each potentially-affected microwave station, in terms of the combinations with which the four key variables are examined to determine the worst-case combination of all four. Whatever process is used, however, the following should apply: (1) it should be based on the worst-case combination of the four key variable factors – interfering path distance/loss, microwave antenna discrimination, earth station horizon gain, and blockage on the interference path; (2) it should result in the correct identification of the worst-case, critical contour point, and (3) it should be replicable by a recipient coordinator.

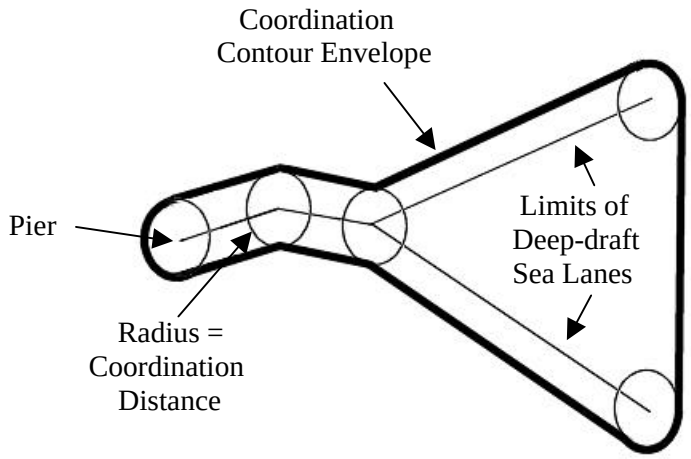
2.5 The Interference Analysis of “Critical Contour Points”

The potential interference to each microwave station should be calculated from its respective critical contour point. Any technical adjustments to the calculated interference levels that are normally used in point-to-point interference analyses are equally applicable to ESV analyses using critical contour points. If the calculated interference meets applicable interference protection objectives, operation at the critical contour point and all other points within the contour is assumed to be non-interfering. If the calculated level of interference, after all available adjustments, fails to meet the objective, operation at the critical contour point (and presumably other points within the contour) is assumed to be interfering.

2.6 Coordination Distance

Coordination will be required for earth station operation when the ESV is within some distance from shore, the "coordination distance." This distance is computed in accordance with FCC and ITU Regulations. Coordination distance is a function of the earth station power-bandwidth transmitted in the horizontal plane in any given direction and the assumed antenna gain and permissible level of interference associated with the victim station.

In determining the coordination area for an in-motion ESV, it is generally only necessary to select a few points on the periphery of the geographical area and construct an envelope of the resulting point coordination contours by straight lines on the map used. The default minimum coordination distance is 100 km.



Construction of the Coordination Envelope

3. ESV INTERFERENCE OBJECTIVES

3.1 Background:

This Recommendation addresses the interference objectives to be used, on an interim basis, to protect against harmful interference to point-to-point microwave systems operating in the 5.925- 6.425 GHz (lower 6 GHz) band. Interim interference protection objectives are being proposed. These objectives are based on modification of the objectives for analog microwave technology, adjusted for the estimated ESV exposure period, and may not be appropriate for protection of systems using digital modulation. As additional information and analyses are made available to the working group, the objectives will be adjusted as appropriate.

The recommended ESV interference objectives provided below address the following situations:

1. Fixed ESV operation while stationary at an identified deep-draft dock or pier;
2. In-motion ESV operation within the coordination distance from shore; and
3. ESV operation at a “scheduled” halt at an identified off-shore anchorage or roads

Since it has been agreed that the conventional short and long-term microwave

interference objectives (-131 and –154 dBW/4KHz)[1] may be applied on an interim basis to fixed and stationary ESV operations, the remaining problem involves the objective for in-motion operations.

The recommended microwave interference protection objective for in-motion ESV operation is based on analysis and discussion centering on the common use of the analog-based objectives, and is intended to be set in such a manner as to provide reasonable assurance that neither the conventional long-term nor short-term objectives will be violated by an interference source operated in motion. The basis of the analysis included a set of assumed ESV operating parameters (i.e., maximum 200 passes per year; minimum underway speed of 5 knots), modeling of ESV interference level versus percentage of time, and an assumption that the resulting ESV interference will be controlled to not exceed a straight line drawn between the long and short-term fixed analog objectives (drawn on a log-log graph of interference level versus percentage-of-time). As a result of this modeling and analysis, a single objective is proposed to control potential ESV interference to microwave systems, at least when based on the commonly used analog earth station interference objectives. Application of the in-motion interference protection objective described below is subject to the ESV operation of interest fitting within the bounds of operational characteristics as defined earlier.

It is also recognized that an ESV-equipped vessel may come to a halt at an offshore location within the identified in-motion operating area – either a “scheduled” halt at an anchorage or roads, or on an “unscheduled” halt at some other point. Section 3.2, below, addresses required interference levels and Section 4 addresses operational control requirements applicable to each of those circumstances.

To address the concern about the appropriateness of using analog-based interference objectives in the protection of digital microwave radio systems, additional work is necessary and the results of that additional work may result in a recommendation that overrides this one. In the meantime, however, the interference protection objectives described below may be used on an interim basis. No grandfathering of coordination will exist in the event the objectives are changed.

3.2 Interference Objectives:

The following microwave interference protection objectives may be applied, on an interim basis, to ESV operations:

3.2.1 Fixed (Docked) ESV Operations: The conventional short and long-term

[1] See FCC Rule Section 25.251(b) and ITU-R Appendix S-7, formerly Appendix 28.

microwave interference protection objectives apply.

3.2.2 In-Motion ESV Operations: On a provisional basis, pending additional information on appropriate objectives for digital microwave radio, a single objective of -145 dBW/4kHz, which is based on aggregate ESV exposure between –145 and –154 dBW/4kHz of 0.6% of the time, should be used to protect 6 GHz point-to-point microwave systems from potential interference from ESVs operated in motion. Pending additional information, normal propagation conditions also apply to the use of this objective. Should this interference protection objective be changed, the in-motion ESV operation should be re-coordinated using the revised objective(s). Because of the lower threshold of low capacity, narrow band receivers, the long term interference objective will be used for these paths. Therefore, for receivers with a channel bandwidth of less than 10 MHz, an objective of –154dBW/4kHz will be used. For receivers with a channel bandwidth of 10 MHz or greater, an objective of –145dBW/4kHz will be used. The impact of ATPC on these objectives requires further study.[2]

3.2.3 ESV Operations at a Halt in the In-Motion Operating Area: Identified anchorages (roads) used by ESV-equipped vessels should be coordinated using the conventional short-and long-term microwave interference protection objectives. Should an ESV-equipped vessel stop at a point in the in-motion operating area not coordinated using those objectives, ESV operation should cease for the period that the vessel is stationary or operating at a speed less than the modeling speed.

4. OPERATIONAL CONTROLS

For each channel used by the ESV in each coordination zone (port):

An ESV licensee will equip each shipboard station with a GPS controlled device that will cause transmissions from the shipboard station to automatically cease when the vessel crosses the boundary into an area where it could potentially cause interference into a terrestrial receiver.

1. In the absence of completed prior coordination, that boundary is the coordination distance from shore.

2. If all cases of potential interference have been cleared from the point the vessel crosses the coordination zone boundary to port, and coordination is complete, no boundary exists, and the shipboard transmitter will not be required to automatically cease operation. If prior coordination is complete and shows that shipboard transmissions within the appropriate contour from shore will only be on frequencies

[2] See FCC Rule Section 101.147(i) regarding channel limitations for narrow band radios.

cleared for the entire transit from coordination boundary to port, installation of automatic transmitter control equipment will not be required.

3. If the parties to coordination agree that operation of the shipboard station will not cause interference within a portion of the coordination area, but will cause interference within another portion of the coordination area, the boundary is the agreed-upon line(s) separating those areas.

5. PRIOR COORDINATION NOTICE (PCN) PROCEDURE AND DATA REQUIREMENTS

Initial boundary proposals and interference calculations will be made by the ESV licensee and forwarded with a prior coordination notice for review and evaluation by potentially affected parties.

The current proposed usage of the ESV is divided into two separate areas of operation, the fixed dock site and the mobile route area.

Procedure:

1. The fixed dock site information will contain all of the required data for any Earth Station PCN including horizon elevation angles per FCC Rule 25.203(c) and NSMA Recommendation WG3.86.002. Each fixed operating point (dock site antenna location) will be identified to within one-second accuracy per FCC Rules; transmitter elevation information will reflect antenna height at high tide. If Multiple anchoring berths are located at a particular site, each berth must be identified within the accuracy requirements.

2. The mobile route area information will contain all of the standard Earth Station parameters per FCC Rule 25.203(c) and NSMA Recommendation WG3.86.002 with the following additions:

    a. The specified mobile route area defined by the latitude/longitude location of the route break points and any defined area other than the specific route plan. The data basis for the break points must be indicated. The mobile route area would be defined up to the point it reaches the coordination distance from shore or that distance from an offshore terrestrial receiver, whichever is greater;

b. A map or diagram indicating the high seas operating area, channel route, docking sites and coastline;

c. The map will also show the coordination contour of the mobile route area (a contour which is the ESV coordination distance beyond the boundary of the ESV operating area);

d. Proposed clearance information must include support data to be considered;

e. A list of the mobile route area critical points for each of the microwave stations analyzed within the applicable coordination distance.

6. ESV ACCOMMODATION OF FUTURE FIXED INSTALLATIONS

The current proposed usage of the ESV, as noted above, encompasses two separate areas of operation, the Fixed-Dock Site (FDS) and the Mobile Route Area (MRA). The MRA is proposed with secondary status with a stipulation per FCC Rules of non-interference with any primary fixed terrestrial microwave path. This proposal addresses the process for the Coordination Industry to prevent interference from the MRA into future primary terrestrial paths. The FDS will not be addressed since it can be analyzed per the current standard coordination process for temporary facilities.

Procedure:

1. All future terrestrial point-to-point Prior Coordination Notices (PCNs) in the operational band and within coordination distance of the MRA should be forwarded to the ESV licensee or its designated coordination agent.

2. As a secondary user, the ESV licensee/agent is responsible for analyzing each PCN, determining the impact from the MRA, and responding to the coordinator with its conclusions. These conclusions should be reported consistent with the format and data requirements of NSMA Recommendation WG3.91.029 (also referenced by TIA Bulletin 10, Annex G-2.2.4). The responses would be defined as follows:

    a. Meets applicable industry objectives based on Line of Sight (LOS) calculations and will not affect the terrestrial path. Individual case details supplied;

b. Fails to meet the objectives based on LOS calculations, however, will not affect the terrestrial path because of specified clearance information. Individual case details supplied with the additional support data for clearance;

c. Fails to meet the objectives based on LOS or other calculations. Frequency limitations or other changes will be required by the ESV operator to avoid interference. Individual case details supplied with the required changes to clear the potential interference. These changes will be defined in the response letter and executed when the terrestrial path licensee indicates the path will be placed in operation.

3. Upon filing of a terrestrial path affected under Procedure II c, the ESV licensee/agent will be required to do the following:

   a. Modify ESV operations to protect the new station, per the response letter noted in II c, above;

   b. Issue a PCN to notify all microwave licensees (or their designated coordination agents) in the same frequency band, and within coordination distance, of the changed ESV operations;

   c. If the MRA is still proposed, the modified ESV operating parameters will be used for the license application;

   d. If the MRA is applied-for or licensed, the notification of changed ESV operations will be forwarded to the FCC according to its requirements.

4. Every six months the ESV licensee/agent will be required to issue a PCN with the current operational frequencies of each MRA and FDS.

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RECOMMENDATION
WG3.98.049

Source:	Working Group 3
Subject Area:	Coordination Procedures
Title:	Earth Stations on Board Vessels (ESV): Frequency Coordination Procedures

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